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PLANT FOOD

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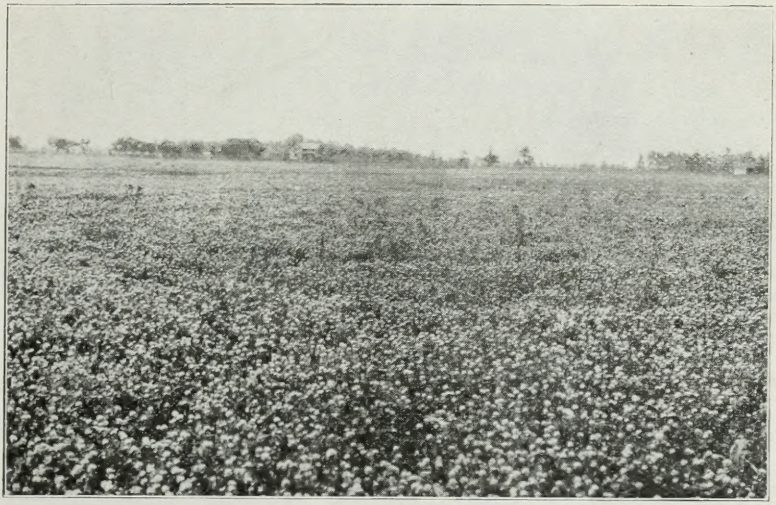

Lime, manure, and vigorous clover
Makes the old farm rich all over.
—Vivian.

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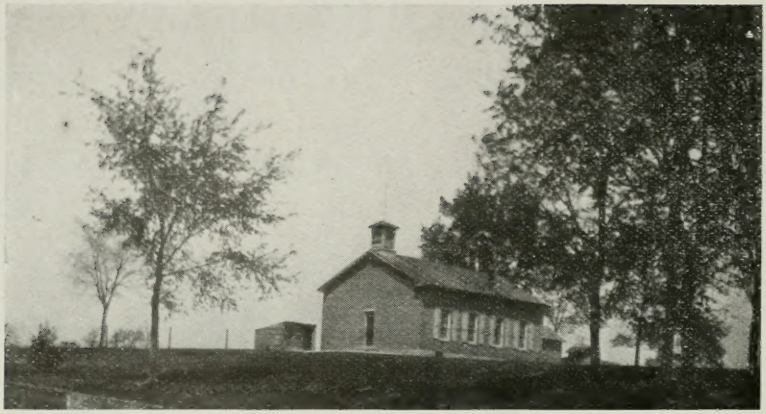
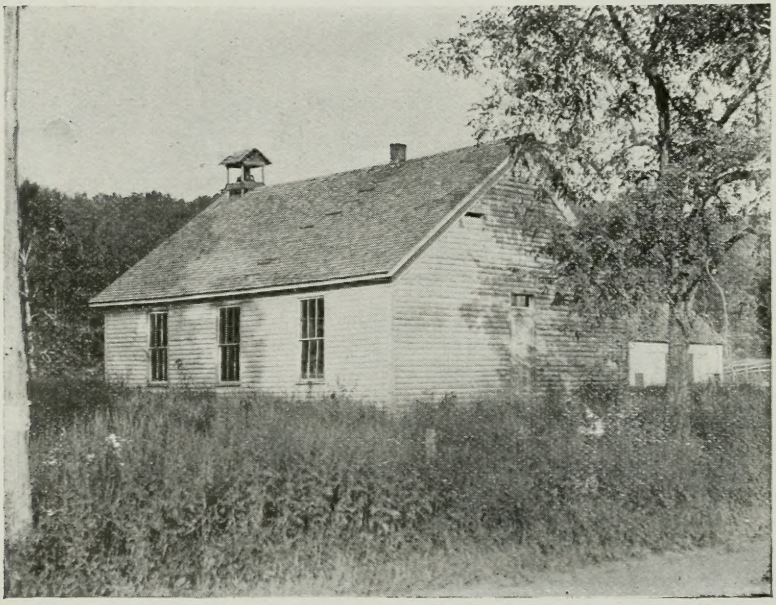
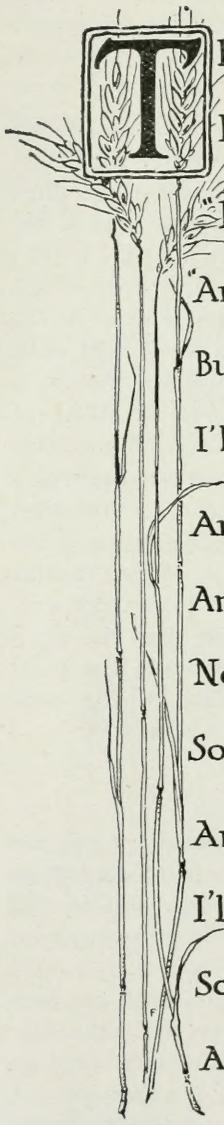


Public pride demands a well-kept schoolground.



Public indifference reflects itself in a school yard overrun with weeds.

THE WISE FARMER



THERE WAS a man in our town
And he was wondrous wise
He knew that if he wanted crops
He'd have to fertilize.

"It's nitrogen that makes things green"
Said this man of active brain;
"And potash makes the good strong straw,
And phosphate plumps the grain.
But its clearly wrong to waste plant food
On a wet and soggy field;
I'll surely have to put in drains
If I'd increase the yield.

And after I have drained the land
I must plow it deep all over;
And even then I'll not succeed
Unless it will grow clover.
Now acid soils will not produce
A clover sod that's prime;
So if I have a sour soil,
I'll have to put on lime.

And after doing all these things,
To make success more sure,
I'll try my very best to keep
From wasting the manure.
So I'll drain, and lime, and cultivate,
With all that that implies;
And when I've done that thoroughly
I'll manure and fertilize.

·COLLEGE·OF·AGRICULTURE·
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VIVIAN

PLANT FOOD

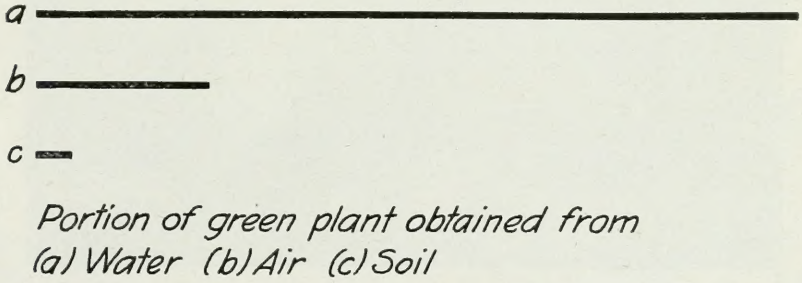
By M. A. Bachtell

Spring is the beginning of the growing season; the days become longer; the sun rises a little higher and shines a little hotter each day, thus making the air warmer. The soil also feels the influence of the sun's rays and begins to take up some of the heat. This process is slow, for the nights are cool and a part of the heat absorbed during the day is then lost. But, after a while, the soil becomes warm enough to start the growth of plants. Then it is that the farmer should place seeds in the ground, for, in close touch with the warm, moist earth, they will swell and soon open to give the tiny plant tucked away inside a chance to unfold and grow. For hundreds of years spring has come in about the same way and at very nearly the same time in every twelve months. One year spring may be slightly cooler than it should be; another year it may be too wet for our ideal of that season; but these conditions also prevailed a hundred years ago. Spring is, however, only the beginning of the growing season. Plant growth continues throughout the summer months and into the fall. Then the days shorten, the sun sinks lower each day, and the cool night takes away from the soil more heat than the sun's feeble rays can replace during the day. As a consequence, the plant dies or goes to rest for the winter, preparatory to taking up its work when spring comes again.

SEED, SOIL AND SEASON

In the production of a crop, three things are necessary; seed, soil into which to put them, and a season during which the plant may grow and mature. These were essentials a hundred years ago; but at that time large crops were grown more easily than they are at present. If it is more difficult to obtain a large crop of wheat than it once was, it must be because the seed, the climate, or the soil has changed. Much has been learned about seed and today it is possible to get better seed than that used one hundred years ago, hence smaller crops cannot be attributed to poor seed. Nor can the cause be a change of climate, for that has not changed. The decline in yields must, then, be due to a change in the soil; the farmer has been growing crops that have taken from the soil important plant food, which he has not been careful to return to it.

A long time ago, a certain man took a willow tree which weighed five pounds and planted it in a tub of dry earth. For five years he watered it regularly with rain water. At the end of that time he cleaned the soil from the roots and carefully weighed the tree. He found that it had increased one hundred and sixty pounds in weight. Did this increase come from the soil? He also weighed the tub of soil and found that it had lost only two ounces, which he thought might have been an error in the weighing. The man thought that the tree had lived on rain water. "This," he said, "is the food of all plants." His conclusion was not correct, however. Later, another man said that plants did not live on water alone but on water and air together. A third man held that this could not be so, saying: "It often happens that two fields side-by-side both receive the same amount of rain and both have the same air yet one is more fertile than the other." This man believed that the food of plants was the fine particles of soil. He thought that if lumps of earth were crushed into dust-like particles, the plant could absorb and digest these very much as an animal digests a piece of meat. This man's ideas were also incorrect. It is now known that the plant does not digest the particles of soil, but that there is something in the soil which the plant takes out and uses as food.



Portion of green plant obtained from (a) Water (b) Air (c) Soil

ELEMENTS OF PLANT FOOD

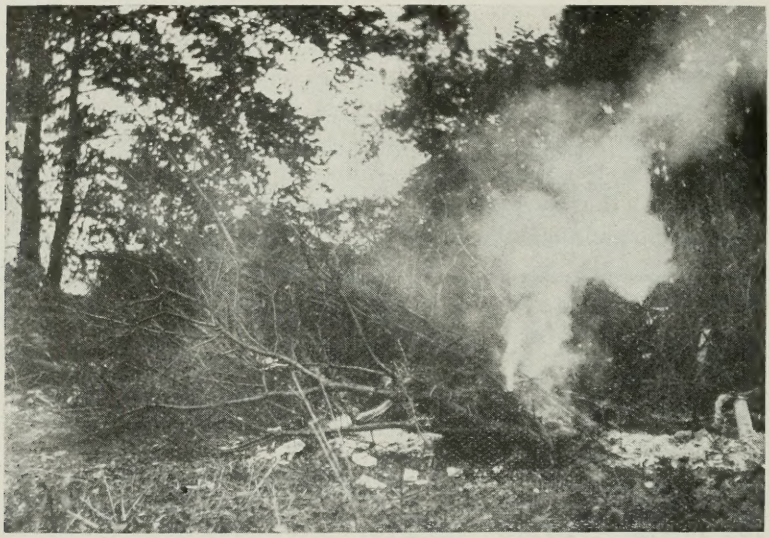
The plant does not obtain all of its food from the soil. A large percentage is taken from the air through tiny openings in the leaves; in this way the plant obtains carbon. A part is secured from water. If a current of electricity is passed through water under proper conditions the water will disappear and two gases, hydrogen and oxygen will be formed. The plant can secure these two elements of food from water. There need be no fear that the supply of carbon, hydrogen and oxygen will ever be exhausted.

There are in the soil ten other elements which the plant uses as food; nitrogen, phosphorus, potassium, calcium, magnesium, iron, sulphur, sodium, chlorine, and silicon. If one of these is lacking or present in too small a quantity, the plant can not grow as it should.

Every time a crop is raised, it takes from the soil a certain amount of these elements. At one time it was thought necessary to return all of the elements in as large amounts as the crops removed. It was later learned that it is necessary to put back only three, nitrogen, phosphorus, and potassium.

HOW THE INDIANS DID

The Indians knew nothing of these elements, but they did know that in time something became wrong with the soil and that by adding certain things to it they could raise more corn. When planting the corn, they placed small fish in the hill. This made the corn stalk grow



When the Indians burned brush to secure ashes, they did not know that they were adding potash to the soil.

larger and greener. When the white men asked the Indians why they used the fish in this way, they replied that it was to feed the corn. The white men laughed because they knew that corn could not eat. The Indians were not so far from the right, for when the fish decayed they furnished nitrogen, which the corn was able to take in through the roots and use as food. After a number of years, the Indians observed that the corn was not growing as it once did. The most natural thing for them to do was to put more fish in the hill at planting time. But this did not entirely remedy the trouble. One year they accidentally planted a row of corn across the place where a brush pile had been burned; where the ashes were, the corn grew vigorously. Observing that ashes were a good thing, they began the custom of drawing logs together,

burning them and scattering the ashes where corn was to be planted. They did not know why this made the corn grow better. Today it is known that the ashes contained a large amount of potassium and some phosphorus. These elements were food for the corn and it was necessary to supply them to the soil before the greatest growth could be secured. Before their addition to the soil, the plant food was not in the right proportion. The fish had added very little except nitrogen, but the corn had been taking out potassium and phosphorus until at last the supply of these had begun to give out; hence it was necessary to put back some.

Plenty of nitrogen means vigorous growth.

The writer is reminded of the oat bin in his father's barn, which was filled at threshing time from the floor of the second story. During the winter, the horses were in the basement and at feeding time it was only necessary to open the chute and the oats came rolling down. The supply seemed to be inexhaustible, but after several months the oats began to come more slowly, finally stopping entirely. The bin was empty and had to be refilled. Oats had been taken out all the time and none put back. Every crop takes out of the soil a certain amount of plant food. The larger the crop, the more food it requires. The equivalent of the plant food removed by every crop that is harvested should be returned to the soil. The problem of the farmer is that of returning it in the most convenient and cheapest way.

There is in every soil a certain amount of plant food. However, the greater part of this is not in the proper condition for plants to use; it first has to be changed.

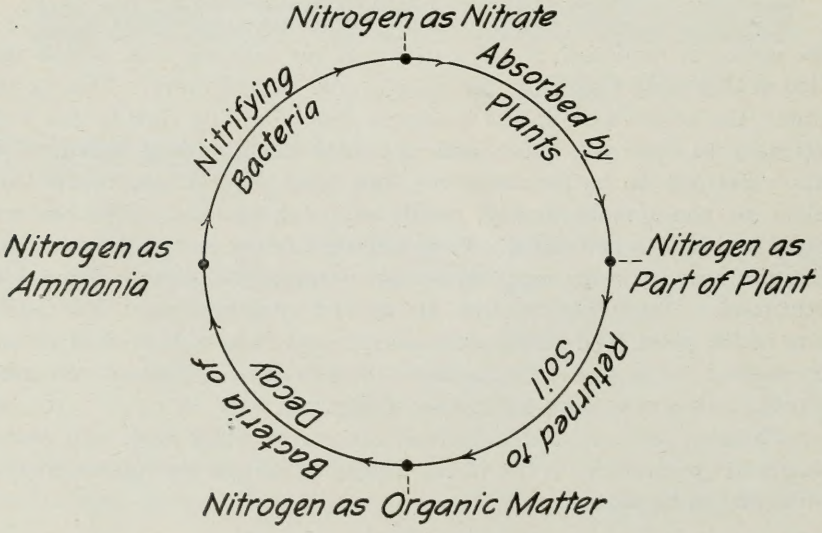
BACTERIA

Soils vary in color. The darker soils contain more nitrogen than do the lighter ones; this element is largely in the form of vegetable matter. The vegetable matter, or "organic matter" as it is more commonly called, feeds the crop just as the fish fed the corn. It must first decay. The decay of the fish was caused by bacteria. These bacteria of decay are very tiny plants which live in the soil. They are of various shapes, some round like marbles, some long like lead pencils, and some twisted like corkscrews. They are so small that a very powerful microscope is required to make them visible. Being so small, a few can not do much work, hence the service of an immense number is necessary.

As the fish decayed, ammonia was formed. If you wish to know what this is, take a cautious smell of the ammonia bottle. Ammonia contains nitrogen, but a plant can not use ammonia as a food any more than one can use raw potatoes. The potatoes must first be prepared; the ammonia must be prepared for the use of the plants. Another kind of bacteria takes the ammonia and, by a process called nitrification, changes it into a nitrate. These are nitrifying bacteria. All nitrogen which the plant takes up must be in the form of a nitrate.

NITROGEN

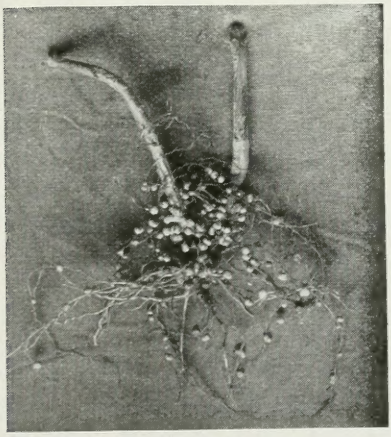
Not only fish but all vegetable matter contains some nitrogen. The plants that die and fall back upon the soil gradually become covered with earth and undergo the process of decay. Their nitrogen is changed to the nitrate form and again used by other plants. The manure which the farmer hauls to the field and plows under has to pass through the same changes. Nitrogen, in fact, really travels in a cycle.



First, ammonia is formed by the decay of organic matter; this is then changed to a nitrate which is used by plants; and when the plant dies and decays, the nitrogen is again ready to go through the same changes. On the farm, however, there is a steady loss of this element; some of the crops are hauled away and sold. The nitrogen, as well as the phosphorus and potassium which they contain, is carried away with them. These three elements must be returned to the soil, or it will become poorer from year to year. As the soil loses its plant food, the yield will decrease until it no longer pays to grow the crops. That land is then said to be worn out, or exhausted. If the farmer could obtain enough fish and ashes, he could return the nitrogen and potassium in about the best forms, but it would be impossible to catch enough fish for that purpose and it would cost too much to buy them. Some other way must be found by which these elements may be restored to the soil.

HOW CLOVER ENRICHES THE SOIL

Nitrogen is all around us in the air. We can not see it, taste it, nor smell it, but we know that it is present. It is also present in the air which is in the soil. Clover, with the help of bacteria, can use this nitrogen; hence, if this crop is grown and plowed under instead of being cut, nitrogen will be added to the soil. But the farmer finds it more profitable to cut the clover, feed it to his animals and return the nitrogen to the field in the form of manure. This is a more profitable method than plowing the clover under if care has been taken to protect the manure from the rain so that the plant food has not been washed out and lost. Growing clover adds nitrogen to the soil because of the bacteria which live on its roots. These organisms cannot live on the roots of other crops, such as corn and wheat, which must get their nitrogen from the soil. After a crop of this kind is cut, the soil contains less nitrogen than it did before the crop was grown. Clover replaces the nitrogen which the other crops remove. These nitrogen-gathering bacteria live in the soil. When the clover begins to grow, they work their way into the roots. Wherever they come to rest, a swelling forms. This swelling is called a nodule or tubercle. Inside these nodules the bacteria live and reproduce themselves; in



Nodules on the roots of a legume (Soy Bean)

a short time there is a large colony in each tubercle. They take the nitrogen from the soil air and fix it in such a way that the clover can use it. It should be kept in mind that the bacteria, and not the clover, gather the nitrogen from the air. If they are not in the soil or if they are present and something happens to prevent them from working, the clover will not grow as well as it should because a part of its food supply has been taken away. When soils are sour or acid, bacteria can not work very well. The sourness of vinegar is due to acetic acid; the sourness of milk, to lactic acid. Similar acids known as organic acids are formed in the soil when organic matter decays. Unless they are counteracted, the soil becomes sour. This acid condition will interfere with the work of the bacteria which are gathering nitrogen for the clover. The cheapest way to overcome these acids is by putting lime on the soil. When the lime has accomplished its purpose, the bacteria can renew their task of gathering nitrogen from the air. Because of this fact, clover will often make a better growth after the soil has had an application of lime. Some soils were formed in such a way that they have contained from the beginning a large supply of lime or limestone. Soils so formed do not easily become sour and rarely need to have lime added to them. Lime is not added to the soil as a plant food, but is applied for the purpose of overcoming sourness so that the bacteria can the better do their work of gathering and preparing nitrogen for the plant. Not only the nitrogen-gathering but also the nitrifying bacteria can do better work after lime has been added to sour soils.

Growing clover is the cheapest method of keeping up the supply of nitrogen in the soil. Nitrogen may be bought, but enough to produce one bushel of corn costs nearly twenty cents and this method is usually too expensive. However, nitrogen is one of the elements which is sometimes bought in a fertilizer. The important point to remember is that the supply in the soil can be kept up by growing clover in each field once every three or four years provided the crop is plowed under or fed on the farm. In the latter case, care should be taken to return the manure to the soil.

POTASSIUM

Potassium is present in rather large amounts in most of our clay soils. Soils were formed from the rocks that covered the surface of the earth thousands of years ago. Gradually these rocks crumbled to pieces and were ground to the fineness of dust and, when decaying vegetable matter became mixed with this material, a soil was formed. The soils then contained plant food similar to that of the rocks from which they were produced. The rocks from which clay was formed were rich in potassium or potash, hence these soils contain a large amount of this

material, most of which, however, is in a form in which the plant can not use it. Before plant food can be used, it must be dissolved in water. A small stone placed in a glass of water will not change in appearance; a lump of sugar, however, will soon dissolve and disappear. The stone is insoluble; the sugar, soluble. Most of the potassium in the soil is insoluble, but it may be made soluble. Anything that rots or decays in the soil will help to bring about this change. Clover and timothy sod, straw and manure are valuable because, when they are plowed under, something that will decay is added to the soil. Sometimes a green crop of rye or clover is plowed under to increase the amount of decaying vegetable matter in the soil.

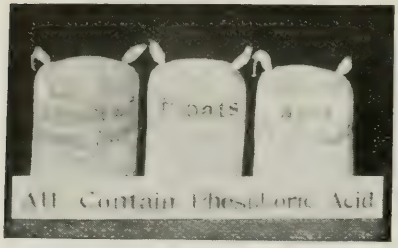
Since there is such a store of potassium in the soil, it is not necessary to replace all that is taken out by crops. If a man has a large amount of money in the bank he does not want to draw out and use the entire amount, but he does not hesitate to use the interest which accrues every six months. The same principle may be applied to the use of potash which slowly becomes available from the large deposit in the soil. If the crops are fed to animals and the manure returned to the fields, most of the potassium which was taken from the soil is returned. But if the crops are sold, the potash is carried away and part of it should be purchased and returned to the soil.

Potassium in the commercial form comes from Germany. It is not so expensive as nitrogen, one pound costing about six cents; one pound of nitrogen costs nearly three times that amount. Potassium is also bought in some fertilizers. It is spoken of, however, as potash.

PHOSPHORUS

The third element of plant food which must be returned to the soil is phosphorus. This term is not as commonly used as "phosphoric acid," which has reference to the same plant food. Most soils contain more nitrogen and potassium than phosphorus, consequently, it is usually the supply of this element which determines the yield. There is an old saying "A chain is no stronger than its weakest link," which might be changed to read "The average soil will not produce a larger crop than the supply of phosphorus will permit." To secure large crops, a large supply of phosphorus must be kept in the soil. The sale of grain, milk, or livestock takes away from the farm a large amount of phosphorus, which should be returned. It can be purchased in three forms. In Florida, Tennesse and South Carolina are found rocks which contain phosphorus. These are quarried and ground very fine, in to what is called ground phosphate rock or floats. This may be used by first being mixed with manure. The phosphorus is not in the condition for plants to use until made so by decay of the manure.

There are, however, many who are not livestock farmers, and therefore cannot use floats. For their use, a product known as acid phosphate is prepared by mixing sulphuric acid with ground phosphate rock. Acid phosphate contains phosphorus in a form in which the plant can use it and is therefore adapted to the needs of the grain farmer as well as the grower of livestock. Although it is called acid phosphate and acid is used in its manufacture, the completed product contains no acid. Sulphuric acid is dangerous to handle but, when it combines with floats, it is changed to a harmless material. Acid phosphate adds no acid to the soil.



Forms in which phosphoric acid may be purchased

Phosphorus is also found in bones and a large number of farmers prefer to buy it in this form. The bones must first be ground; the finer they are ground, the more valuable they are as fertilizer. The ground product is known as raw bone meal. If the bone is first steamed to take out some of the fatty material and then ground, it is known as steamed bone meal, which is a better fertilizer than raw bone meal.

FERTILIZERS

Materials which contain plant food and are used as fertilizers are listed below. The terms phosphoric acid and potash are used instead of phosphorus and potassium. Letters are sometimes used to indicate the different plant foods; viz: N. for nitrogen; P. for phosphorus; P_2O_5 for phosphoric acid; K. for potassium and K_2O for potash.

Sodium Nitrate contains about 16 % of Nitrogen or N.
Acid Phosphate " " 14 % " Phosphoric Acid or P_2O_5
Steamed Bone Meal " " 28 % " Phosphoric Acid or P_2O_5
Muriate of Potash " " 50 % " Potash or K_2O
Sulphate " " " " 53 % " Potash or K_2O

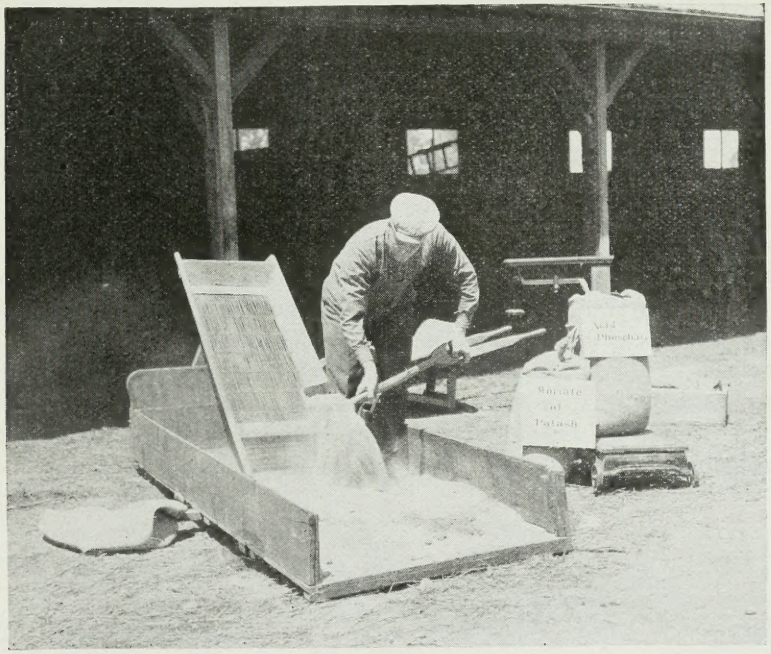
To find the amount of plant food in 100 pounds of each of these materials is simply a problem in percentage. If sodium nitrate contains 16 per cent of nitrogen, 100 pounds of that material will contain 16 per cent of 100 pounds which is 16 pounds of nitrogen.

Any two or any three of these ingredients may be put together to form a mixed fertilizer. Mixed fertilizers are known by the percents of plant food which they contain. Thus a 3 - 10 - 5 fertilizer means one which contains 3 per cent of nitrogen, 10 per cent of phosphoric acid and 5 per cent of potash. One hundred pounds of such a fertilizer contains 3 pounds of nitrogen, 10 pounds of phosphoric acid and 5 pounds of potash. Other examples are 1 - 8 - 2 and 2 - 8 - 4 fertilizers.

The table gives a list of crops and the amount of plant food which they remove from the soil.

	Nitrogen	*Phosphoric Acid*	*Potash*
50 Bu. crop of corn removes	50 lbs	15 lbs.	12 lbs
50 " " " oats "	32 "	15 "	11 "
25 " " " wheat "	30 "	12 "	6 "
2 Ton " " Clover "	0 "	17 "	54 "
1 Ton of Timothy "	17 "	6 "	34 "
150 Bu. of Potatoes "	30 "	14 "	52 "

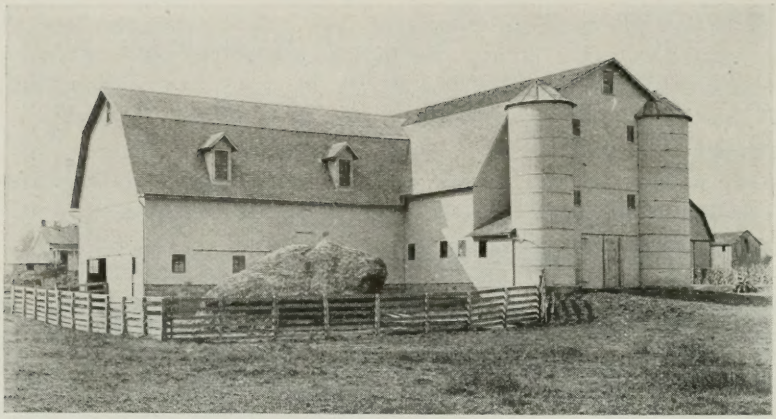
Clover secures nitrogen from the air.



Preparing a balanced ration for plants

From these two tables, the amount of plant food removed by a crop of any size and the amount of fertilizer required to replace it are easily calculated. Nitrogen need not be purchased if clover is grown; all the potash removed by the crop need not be returned if the manure is used; but all the phosphoric acid used should be returned.

If a 50-bushel crop of corn removes 15 pounds of phosphoric acid, and acid phosphate contains 14 per cent of phosphoric acid, it will require 107 pounds (15 pounds is 14 per cent of 107 pounds) of acid phosphate to replace the amount of phosphoric acid removed by the corn. It will require only half that amount or 53½ pounds of steamed

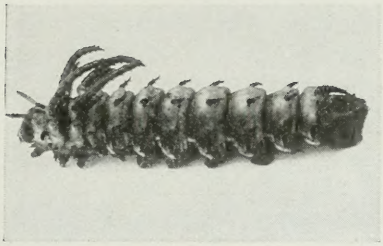


When the soils of a country are rich, the people are prosperous.

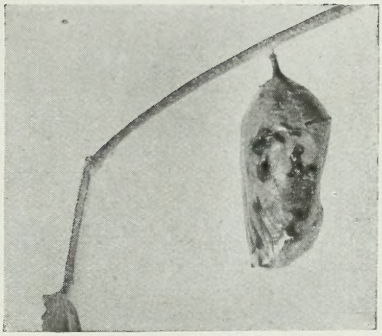
bone meal since that material contains 28 per cent of phosphoric acid. By a similar process, the amount for any crop may be determined.

An Eastern King once asked his wise men for a motto which would be appropriate for all occasions. They brought his Majesty the following: "This, too, shall pass away." We do not wish to apply this motto to the fertility of the soil, for upon that fertility depends our food supply. When the soils of a country are rich, the people are prosperous; when the fertility is exhausted, the people become poor.

Wasting plant food



Larva of the Regal Moth



Cocoon of the Monarch Butterfly

CAN YOU CALL IT BY NAME?

During your walks this fall you will no doubt meet some bird, insect, or plant that has long been a stranger to you. Let us help you to learn its name and to become acquainted with its habits. It may be one whose services contribute to your welfare, or its dress, form, or music may so deceive you that a lack of information concerning it will cause you to place it upon the "black list." How much better it is to be able to point to a plant and say "That is dog's fennel" or "That is ragweed" instead of "That is a weed." Send the specimen to A. B. Graham, College of Agriculture, Columbus, Ohio.

FARMERS' WEEK

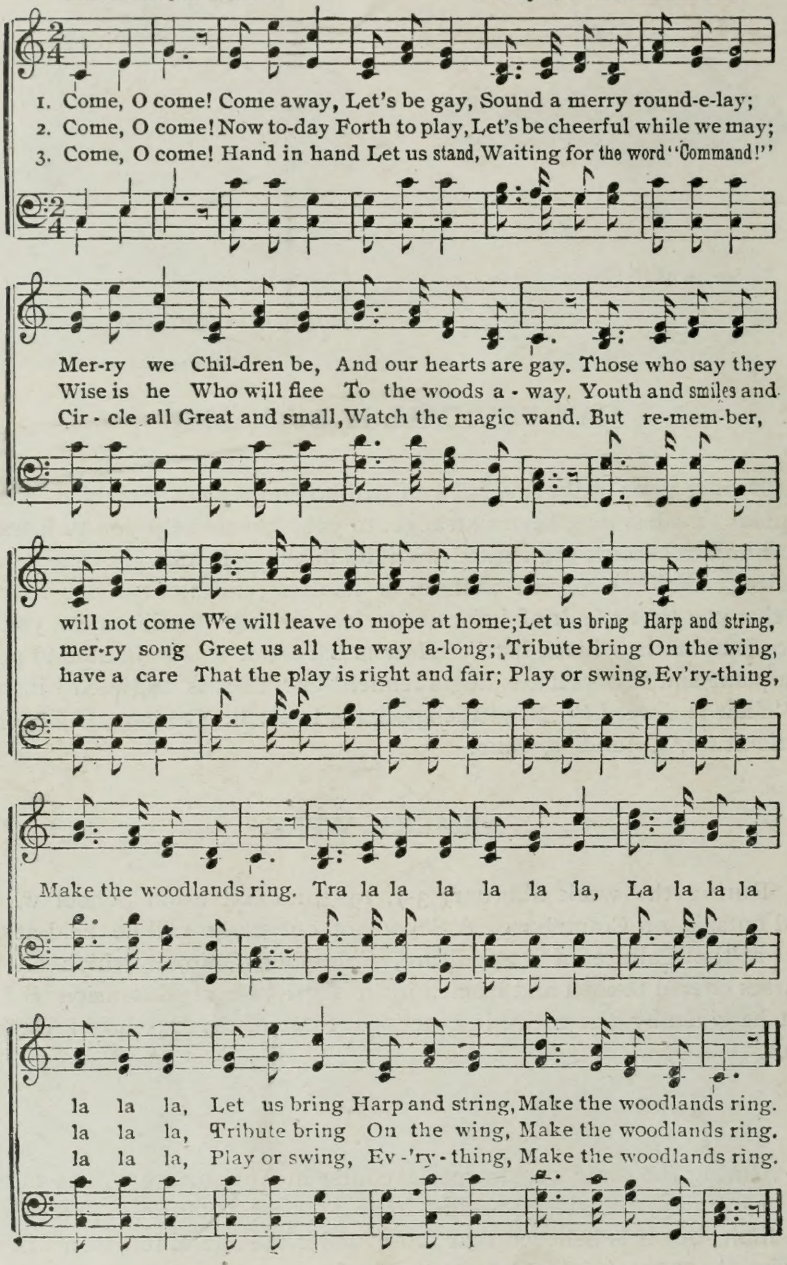
During the week February 3-7, 1913, no Extension School will be held outside of Columbus. A School of one week will be held at this time at the College of Agriculture, Columbus, Ohio, at which all the courses offered to men and women in an Agricultural Extension School will be given by the entire instructional force of the Extension Department.

BOYS' AND GIRLS' WEEK

During the same week, a special course in Agriculture will be offered for boys and a special course in Home Making for girls. There is no age limit, but it is believed that those under the age of fourteen will not receive the greatest benefit from the work.

Make the Woodlands Ring.

Translated by J. H. K. Arr. by J. H. KURZENKNABE.



From American School Songs,
Hope Publishing Company, Chicago.